For the sake of certain studies in hygiene the mean temperature of the wet-bulb thermometer has been given each month. The thermometer from which this temperature is read is whirled at the rate of about 10 feet per second within the light wooden shelter that protects from direct radiation. The average wet bulb for the year can be easily inferred from the mean temperature and dew-point of Table I as the wet-bulb reading is approximately midway between these two.

The total quantity of moisture in the air for the current year can be found by the table given on pages 539–540 of the Annual Summary for 1894, and does not differ to any important extent from the figures there given for that year.

FREQUENCY OF THUNDERSTORMS.

The successive MONTHLY WEATHER REVIEWS have given for each day and each State the number of thunderstorms reported by both regular and voluntary observers. Tables VI and VII give a summary of these monthly tables. In order to ascertain the relative frequency of thunderstorms, as explained in the Summary for 1884, it is proper to divide the number of storms reported by the number of stations in order to deduce the average number per station. The results of this division are given in the eighth column of the following table, which shows that the greatest frequencies per station per year are: Florida, 36.5; Louisiana, 20.7; Minnesota, 18.1; Missouri, 17.4. The smallest frequencies are: Oregon, 2.5; Washington, 2.2. The product of the observed number of thunderstorms by the reduction factors given in column five of the following table would give the approximate total number of thunderstorms for the respective States, which total number, of course, depends largely on the area of the State, and is omitted from this table, as it has no meteorological significance as compared with the frequency per station.

FREQUENCY OF AURORAS.

Tables VIII and IX give a summary of the detailed tables of auroral frequency in the respective MONTHLY WEATHER REVIEWS. In the absence of more precise knowledge, it is assumed that the number of observers reporting all auroras is the same as those reporting all thunderstorms; the total number of either class of observers is decidedly less than the total number of those who report rainfall and temperature. The total number of auroras reported divided by the number of observing stations for any State gives the relative frequency per station, and this number relates to a physical phenomenon and is comparable with similar ratios for other parts of the world, provided the aurora is so low as not to be obscured by a cloudy sky. On the other hand, if the auroral light emanate from a region far above the cloud, then a further correction for cloudiness is needed, but this has not been applied in the present case, as the Editor believes that we have no certain proof as to the extreme altitude of the auroras, and that, on the other hand, there are many reasons to believe that it emanates from the cloud region itself and stands in intimate connection with the condensation of moisture by passing through a critical condition of molecular instability that apparently attends the formation of rain and snow.

Frequency of thunderstorms and auroras during 1895.

State.	Areas in units of 10,000 sq. miles.	Number of stations.		Reduction factor.	Total for 1895.		Frequency per station.	
		Needed.	Reporting.		Thunderstorms.	Auroras.	Thunderstorms.	Auroras.
Alabama	5.1	128	45	2.8	382	0	8.5	0.00
Arizona	11.4	385	30	12.8	190	0	6.3	0.00
Arkansas	5.2	130	40	3.2	393	0	9.8	0.00
California	15.8	395	115	3.4	157	3	1.4	0.03
Colorado	10.4	260	75	3.4	765	37	10.2	0.49
Connecticut	0.5	12	20	0.6	286	29	14.3	1.45
Delaware	0.2	5	6	0.8	85	26	14.2	4.36
District of Columbia	0.01	0.2	2	0.5	32	0	16.0	0.00
Florida	5.9	148	30	4.9	1,094	0	36.5	0.00
Georgia	5.8	145	45	3.2	371	0	8.2	0.00
Idaho	8.6	215	26	8.3	168	37	6.5	1.42
Illinois	5.5	138	75	1.8	955	90	12.7	1.20
Indiana	3.4	85	35	2.4	339	20	9.7	0.57
Indian Territory	6.9	172	5	34.4	42	0	8.4	0.00
Iowa	5.5	138	80	1.7	861	128	1.8	1.60
Kansas	8.1	202	65	3.1	519	32	8.0	0.49
Kentucky	3.8	95	35	2.7	212	4	6.1	0.11
Louisiana	4.1	102	45	2.3	933	0	20.7	0.00
Maine	3.5	88	15	5.9	134	111	8.8	7.40
Maryland	1.1	28	30	0.9	434	18	14.4	0.60
Massachusetts	0.8	20	65	0.3	640	127	9.7	1.95
Michigan	5.6	140	60	2.3	405	106	6.8	1.77
Minnesota	8.4	210	60	3.5	1,086	372	18.1	6.20
Mississippi	4.7	118	40	3.0	578	0	14.4	0.00
Missouri	6.5	162	80	2.0	1,391	17	17.4	0.21
Montana	14.4	360	25	1.4	132	111	5.3	4.44
Nebraska	7.6	190	80	2.4	557	79	7.0	0.99
Nevada	11.2	280	35	8.0	188	24	5.4	0.69
New Hampshire	0.9	22	20	1.1	174	137	8.7	6.85
New Jersey	0.8	20	45	0.4	595	46	13.2	1.02
New Mexico	12.1	302	25	12.1	148	0	5.9	0.00
New York	4.7	118	60	2.0	564	129	9.4	2.10
North Carolina	5.1	128	50	2.6	715	3	14.3	0.06
North Dakota	7.5	185	30	6.2	188	288	9.6	9.60
Ohio	4.0	100	125	0.8	1,360	126	10.9	1.01
Oklahoma	......	......	15	......	106	0	7.1	0.00
Oregon	9.5	238	45	5.3	111	2	2.5	0.04
Pennsylvania	4.6	115	70	1.6	752	27	10.7	0.39
Rhode Island	0.1	2	6	0.3	64	11	10.7	1.43
South Carolina	3.4	85	35	2.4	588	1	16.8	0.03
South Dakota	7.6	190	40	4.8	289	99	7.2	2.48
Tennessee	4.6	115	35	3.3	593	1	16.9	0.03
Texas	27.4	686	75	9.1	604	0	8.1	0.00
Utah	8.4	210	25	8.4	148	0	5.9	0.00
Vermont	1.0	25	12	2.1	151	60	12.6	5.00
Virginia	6.1	152	35	4.3	292	5	8.3	0.14
Washington	7.0	175	45	3.9	97	55	2.2	1.22
West Virginia	2.3	58	30	1.9	270	1	9.0	0.03
Wisconsin	5.3	132	55	2.2	720	277	5.0	5.04
Wyoming	9.8	245	10	24.5	34	8	3.4	0.80

THE ANNUAL SNOWFALL.

By the EDITOR.

The successive MONTHLY WEATHER REVIEWS give tables and charts showing the total snowfall during the month; the annual summaries may be made by presenting these monthly sums, either by calendar years, or by totals for the respective winters. Each method has its advantage in connection with some special study, but, both from an agricultural point of view and from the point of view of the geologist who is studying the phenomena of the Glacial epochs and that of the student of river flow, it is especially desirable to study the snowfall of the entire winter as a whole, avoiding the break at the 1st of January that is introduced by the tabulation according to calendar years. The Editor has therefore prepared from data furnished by Mr. A. J. Henry for the United States, and by Prof. R. F. Stupart for the Dominion of Canada the accompanying tables, X and XI, respectively. These tables show the total snowfall received during the twelve months beginning July 1 and ending June 30 of the following calendar year. The tables begin with the year 1884, when the observers of the United States were generally requested to measure and record snowfall in a uniform manner, but many individual records could be compiled for earlier years. It may be possible, by charting the individual snowfalls, to insert approximate interpolated values for occasional missing years, and thus obtain a set of normals that shall be uniformly intercomparable, but this desirable step is deferred until the end of the lustrum 1896–1900, as adopted by the International Meteorological Congress.

The depth of snowfall is given as measured in inches when freshly fallen, and before it has to any great extent become packed either by its own weight, or by the wind, or by melting and re-gelation. Under these circumstances, it is not very erroneous to assume that 10 inches of snow would reduce by melting to 1 inch of water. The ratio 10 is known to be occasionally too small; instances of very light snow have occurred where the ratio is as large as 20, whereas in very wet snow ratios of 8, 7, and even 4 have been known; but 10 is considered as a very fair average for the United States and Canada. If, therefore, the depths as given in Tables X and XI be divided by 10 we obtain the equivalent water, and if this be divided by the total precipitation for the year we obtain the snowfall expressed as a percentage of the total snow and rain. A comparison of the total accumulated snowfall with the actual depth of snow lying on the ground, as published either in the MONTHLY WEATHER REVIEW or in the weekly chart of Depth of Snow on the Ground, published by the Weather Bureau, must impress one with the conviction that the accumulation of snow on the ground during the winter is prevented, not by rainfall, nor yet by its melting and penetration into the soil, but, especially and almost entirely, by the evaporation produced by the strong dry winds in the presence of sunshine. The accumulation of snow that in recent geologic times formed a general glaciation over the Lake Region, St. Lawrence Valley, and the neighboring regions, may have been due to the preservation of the snow by cloudy, foggy weather and moist winds, rather than to any excessive snowfall, and such a change in the climate and winds would be produced if the Rocky Mountain Plateau were submerged and the interior plains of the United States and Canada were covered by a shallow sea.

The enormous snowfalls recorded at high stations, such as Pikes Peak, show the influence of elevation above the surrounding country. The contrast of snowfall at Denver and Pikes Peak is like that between Mount Washington and its surrounding low land stations. In these and similar cases there is a tendency to snowfall with every passing cloud; in fact, the cloud that envelopes the summit is generally a local one, due to the upward deflection of winds striking the mountain side. It is safe to say that a broad plateau at the level of Pikes Peak would not show any snowfall such as recorded at that station, except, perhaps, at its immediate windward edge. The accumulation of hoar frost or frostwork on mountain summits is not to be confounded with the actual snowfall, no more than the cloud particles caught in the raingauge should be confounded with rainfall. Both the frostwork and the catch of fog in the gauge are like the drip from the trees in foggy weather, to be considered as moisture forcibly extracted from the air by contact with obstacles, and not as rain or snow naturally precipitated by force of gravity. Still, in the growth of a glacier and in the irrigation of dry soil, such formations of frostwork and drip have an appreciable importance.

From an agricultural point of view the quantity of snowfall has a twofold importance. A small fraction is melted by virtue of the warmth of the soil and percolates through it, but the principal work of the snow covering is to retain in the soil what little moisture may be there and to keep the surface at a uniform temperature near the freezing point, while the upper surface of the snow experiences the evaporation by day and the low temperature at night that would otherwise occur at the bare surface of the ground.

From a meteorological point of view the covering of the land by the snow has an important bearing on the temperature and moisture of the air and resulting winds. The air in contact with a widespread covering of snow is cooled down to especially low temperatures during the nighttime and the winter season by radiation that is uncompensated by heat from other sources; whereas during the daytime the solar radiation is largely consumed in melting a small thickness of snow; so that both during the day and the night the air over a field of snow is colder than over the bare ground.

REDUCTION OF BAROMETRIC PRESSURE TO SEA LEVEL.

By PARK MORRILL, Forecast Official. (Dated May 5, 1896.)

Under instructions of the Chief of the Weather Bureau, a special board has had under consideration, during the past year, the question of adopting some satisfactory plan of reduction to sea level. It is agreed that the formula of reduction to be used should be that of the International Meteorological Committee. This formula in English measures is—

$$\log \frac{P_0}{P} = \frac{H\left(1-0.378\frac{E}{B}\right)}{60368.6\,[1.00157-0.002039\ (t-32)]} \times$$

$$\times \frac{1}{(1-0.00259\cos.2l)\left(1-\frac{H}{20902950}\right)}$$

Wherein, H=altitude, in feet, of the point of observation.
P=pressure, in inches, at altitude H.
P_0=pressure, in inches, reduced to sea level.
t=mean temperature, in Fahrenheit degrees, of air column.
E=mean vapor pressure, in inches, of air column.
B=mean pressure, in inches, of air column.
l=latitude of point of observation.

In case of observations made in free air above a sea level plane, this formula defines the relations which must exist between the pressures at the point of observation and at sea level vertically below, provided there be no vertical acceleration within the air column and that the effects of viscosity and friction be neglected. That these effects are small has been shown by Professor Ferrel, and we are forced to disregard them because of our observational limitations.

When, however, we seek to apply the sea-level reduction to observations of pressure made at the earth's surface, in which case we have no air column below us, the problem becomes a purely hypothetical one, and the reduction is resorted to only for its assistance in the study of horizontal gradients of pressure. In such use of the above formula we are at once confronted with the question; What temperature and vapor pressure are to be assigned to the imaginary air column? Owing to the small effect of the latter of these factors, no serious error will result from using in the reduction some function of the vapor pressure at the point of observation. The difficulty lies in assigning a proper reduction temperature; this gives no trouble for observations at altitudes below 1,000 feet, as any reasonable modification of the observed temperature will produce inconsiderable change in the reduced pressure for elevations of this magnitude.

The problem of real difficulty is therefore found in the determination of the proper reduction temperature in case of observations at altitudes exceeding 1,000 feet. Among the present stations of the Weather Bureau, with a single excep-